Standard Operating Procedures

1. Groundwater Level Monitoring
2. Groundwater Level Monitoring with Transducers
3. Monitoring Station Inspections
4. Nuisance Water
5. Decontamination of Field Equipment

1 GROUNDWATER LEVEL MONITORING

1.1 Scope and Application

This SOP sets the guidelines for determining the depth to water in an open borehole, cased borehole, production well, monitoring well, or piezometer.

1.2 Method Summary

Generally, water level measurements from boreholes, piezometers, production wells, or monitoring wells are used to construct water table or potentiometric surface maps. Ideally, water level measurements at a given site should be collected within a 24-hour period. Certain situations may necessitate that all water level measurements be taken within a shorter time interval. These situations may include:

- the magnitude of observed changes between wells appears too large
- atmospheric pressure changes
- aquifers that are tidally influenced
- aquifers affected by river stage, impoundments, and/or unlined ditches
- aquifers stressed by intermittent pumping of production wells
- aquifers being actively recharged due to precipitation events

Most often, however, water level collection within a groundwater basin will require several weeks to perform.

A survey mark or reference point (RP) must be placed on the casing or sounding tube for use as an RP for measurement. Many times the lip of the riser pipe or sounding tube will not be flat, so the exact location of measurement must be marked. Another measuring reference must be placed on the grout apron or ground surface. This reference is referred to as the site point (SP). Both the RP and SP should be documented on the site sketch and by photograph.

Data should be collected from the least to the most contaminated wells (if necessary). Working with decontaminated equipment, lower the water level measurement device into the well until the water surface or bottom of the casing is encountered. Measure the distance from the water surface to the RP on the well casing and record on the field data sheet. Repeat the measurement at least twice, 5 minutes apart, to ensure the quality of the measurement. Remove all downhole equipment and replace the well casing cap. Decontaminate as directed in the project work plan or in *Section 5 – Decontamination of Field Equipment* of this SOP document between each well and at the end of the day.

1.3 Interferences and Potential Problems

- The chalk used on steel tape may contaminate a well. Check the chalk type against well water quality requirements before using this method.

- Some types of electric sounders use metal indicators at 5-foot intervals around a conducting wire. These intervals should be checked with a surveyor's tape periodically to ensure accuracy.
- If oil is present on the water surface, it can insulate the contacts of the probe on an electric sounder or give false readings due to the thickness of the oil. Determining the thickness and density of the oil layer is warranted in order to determine the correct water level. Measure the top of the water surface, below the oil, using a steel tape with oil indicating paste or an equivalent method. Record this level, and note the presence of oil in the well on the field data sheet. Record the level of the top of the oil. The true water level can be estimated by adding three-quarters of the thickness of the oil layer to the oil-water interface elevation (U.S. Geological Survey, 2006).
- Turbulence in a well and/or cascading water can make water level determination difficult with either an electric sounder or steel tape.
- Water levels in newly constructed wells should be allowed to stabilize for a minimum of 24 hours prior to measurement after well construction and development. In low yield situations, recovery may take longer.
- The designated RP should be used at all times to ensure consistency. If the designated RP is not available or was modified or destroyed, a new RP must be designated and documented.
- An airline measures drawdown during pumping. It is only accurate to 0.5 feet unless it is calibrated for various "drawdowns."
- Water levels should be checked at least twice, 5 minutes apart, for consistency and repeatability and to ensure that the water level is not being affected by nearby pumping, cessation of pumping, or recharge.

1.4 Equipment

There are a number of devices that can be used to measure water levels, such as electric sounders, steel tape, or airlines. The device should be adequate to attain an accuracy of 0.01 feet. The following equipment is needed to measure water levels:

1. Water level measurement device and backup
2. Digital camera
3. Tools
4. Keys to access well site
5. Metal tape measure
6. Black electrical tape
7. Chalk (if using steel tape)
8. Paper towels
9. Nitrile gloves
10. Field reference notebook

11. Field data sheets
12. Decontamination solution and equipment
13. Wristwatch or other device with a clock
14. Compressed air for airline measurements

1.5 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and which equipment and supplies are needed.
2. Prepare scheduling and coordinate with staff, well owners, clients, and regulatory agencies, if appropriate.
3. Decontaminate and pre-clean equipment, according to the work plan or *Section 5 –Decontamination of Field Equipment* in this SOP document, and ensure that it is in working order.
4. Research water level trends in the area to become familiar with the range of water levels in the project region. Pay special attention to water levels from the current season.
5. Synchronize your wrist watch or other clock device to Pacific Standard Time or Daylight Saving Time, if it is in effect. Set it to within 1 second of the actual time. Use this site:

   www.time.gov

   (This site is set to adjust to Daylight Saving Time when in effect.)
6. Print a field data sheet for each well to be measured plus extra.

1.6 Procedures

1. Wear clean nitrile gloves at all times when collecting a water level measurement.
2. Perform a general site survey prior to site entry in accordance with the health and safety plan.
3. If possible and where applicable, start at the wells that are least contaminated and proceed to the wells that are most contaminated.
4. Clean all equipment entering the well as specified in the site plan or *Section 5 –Decontamination of Field Equipment* in this SOP document.
5. If required by site-specific conditions, monitor the headspace of the well with a photoionization detector (PID) or flame ionization detector (FID) to determine the presence of volatile organic compounds, and record on the field data sheet.
6. Identify and mark all measurement locations, and record any changes on the field data sheet, the site sketch, and by photograph.
7. Remove well cap.
8. Note well name, well ID, address, date, observer name, and method used on the field data sheet.
9. Lower electric water level measuring device or equivalent (i.e. metal tape or airline) into the well until water surface is encountered. In most cases, an electric sounder will be used. If the electric

sounder is not getting a reading, use a different sounder, the metal tape method, or the airline method, depending on the circumstance.

10. Measure the distance from the water surface to the RP on the well casing. If using an electronic sounder, verify the distance several times by lifting the device a few inches above the water level and slowly lowering it back down until it sounds. If necessary to get a clear tone, adjust the sensitivity of the meter: remove the meter from the well, test the sounder in a bucket of water, adjust the meter sensitivity accordingly, and reinstall the meter in the well. Record all measurements on the field data sheet, and note the time of each measurement in Pacific Standard Time.
11. Note the activity of the well during measurement (i.e. static, dynamic, unknown, or recovering) on the field data sheet. A well is considered recovering for 24 hours after it has turned off.
12. Record the designated RP used (i.e. top of sounding tube, top of casing, plug hole) on the field data sheet.
13. Measure the distance of the ground surface (GS) to the RP (GS to RP), and note on the field data sheet. If the RP is above the ground surface, the GS to RP will be a positive number, and if the RP is below the ground surface, the GS to RP will be a negative number.
14. Check that the photographs are current and the well sketch is up-to-date with the correct RPs and measured GS to RP. If measuring a well for the first time, provide a well sketch using the field sketch form. Always make sure that the GS to RP on the sketch and on the field data sheet are the same and that the RP is clearly marked on the well.
15. Wait 5 minutes to take a second measurement regardless if the activity has changed or not. If the well activity changes, wait at least two minutes to take a measurement after the well turns on/off. If the well activity changes again within that time, make a note of the timing, take a measurement, wait a few minutes (depending on the pump cycling frequency), and take a third measurement.
16. Fill out the field data sheets completely. Provide comments on anything of significance that is not directly implied by the data recorded on the sheet, such as well condition, well property characteristics, well pumping cycles, problems at the well, oil in the well, etc.
17. Remove all downhole equipment, replace well casing cap, and secure, as necessary.
18. Decontaminate the first ten feet or the wetted part of the equipment, whichever is greater, after each water level measurement. If contamination is observed along any other length of the equipment, decontaminate the affected sections. At the end of the day, decontaminate and clean the entire length of the equipment as outlined above. Dry the line before placing it back on the reel.
19. At the end of the day, scan copies of all completed field data sheets, and give them to the project manager. Place the original field data sheets in the project binder.

1.7 Reagents

Decontamination solutions are used in this procedure. Where the decontamination of equipment is required, refer to the site-specific work plan or *Section 5 – Decontamination of Field Equipment* of this SOP document.

1.8 Calculations

To convert depth-to-water measurements to groundwater elevation above mean sea level, use the following equation:

$$Ew = E-D$$

where:

Ew = Elevation of water above mean sea level

E = Elevation above sea level at point of measurement

D = Depth to water

1.9 Quality Assurance/Quality Control

The following general quality assurance/quality control procedures apply:

- All data must be documented on standard field data sheets or within site logbooks. Should log books be used, copies of the pages used must be scanned and placed in the project folder.
- All instrumentation must be operated in accordance with the operating instructions supplied by the manufacturer.
- The water level within each well should be tested at least twice, 5 minutes apart, in order to compare results. Measurements should agree to within 0.01 feet. If they do not, wait another 5 minutes and measure the water level again. Record all measurements.

1.10 Data Validation

Data should be compared to previous data for each well. If data are significantly different, any possible causes should be noted on the field data sheet.

1.11 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and site or project specific health and safety procedures.

1.12 References

U.S. Geological Survey. (2006). *Collection of Water Samples: U.S. Geological Survey Techniques of Water-Resources Investigations*, ver. 2.0. Vol. 9, chap. A4.

2 GROUNDWATER LEVEL MONITORING USING TRANSDUCERS

2.1 Scope and Application

This SOP sets the guidelines for canvassing wells for transducer installation, installing transducers, and retrieving transducer data.

Transducers are used to gain a very accurate understanding of changes in groundwater surface due to climatic variations and the effects of surrounding well activity on the local piezometric level.

2.2 Inspecting Wells for Transducer Suitability

Wells must be assessed for their suitability for transducer installation, considering the following parameters:

- Location in basin or proximity to hydrogeologic features
- Proximity to high volume production wells
- Access to well site
- Access to inside of well for transducer

Transducers must be properly specified to consider past and future water level variations. A transducer that does not have a large enough range can miss data. A transducer that has too large of a range has less accuracy. Proper procedures must be followed to ensure that all information needed for transducer specification is gathered.

2.2.1 Equipment

- Dummy transducers for each size of transducer, extra dummies
- Test line with measurement marks, extra line
- Copper wire
- Pliers
- Digital camera
- Keys to access well sites
- Tools to access well ports
- Water level measurement device (electronic water level indicator, metal tape measure, steel tape, chalk)
- Ruler
- Project notebook
- Pens
- Maps and directions
- Decontamination solution and equipment
- Field data sheets (water level and site inspection for transducer installation forms)

- Well owner contact information for target wells
- Shop towels, rags, or paper towels
- Tag line (for measuring total depth of wells if unknown)
- Water level history graphs for target wells

2.2.2 Preparation

1. Query the database for water elevation history and depth to water from the RP and for current water level monitoring status (by owner or other, at what frequency, etc.). Determine the maximum and minimum water levels within the well in recent history while the well is in its current condition (i.e. active or inactive).
2. Determine good candidate wells for inspection based on proximity to other pumping and non-pumping wells and other information pertaining to the project goals.
3. Contact well owners to determine access to site, access to inside of well, and type of onsite chlorination (if any). Drip chlorination may damage the direct-read cable and will destroy the stainless steel wire.
4. Collect and review former field data sheets for each well to determine missing information.
5. Obtain necessary sampling and monitoring equipment.
6. Decontaminate all equipment as outlined in the work plan or *Section 5 – Decontamination of Field Equipment* in this SOP document before using it on each well, and ensure that it is in good working order.
7. Coordinate field work with staff, clients, well owners, and regulatory agencies, as appropriate.

2.2.3 Procedures

1. Perform a general site survey prior to site entry in accordance with the health and safety plan. And, if required by site-specific conditions, monitor the headspace of the well with PID or FID to determine the presence of volatile organic compounds and record on the field data sheets.
2. Measure the water level within the well.
3. Use the maximum water level determined in Step 1 of *Section 2.2.2 – Preparation* above to determine the total installation depth of the transducer (usually 10 to 20 feet below the maximum measured water depth).
4. Carefully lower the decontaminated "dummy" transducer into the well to the expected depth of the transducer (see step 3 above). Note any depths where the dummy transducer gets caught, comes to rest, encounters the well bottom, etc. Carefully remove the dummy from the well.
5. Completely fill out the site inspection for transducer installation form.
6. Decontaminate all equipment as outlined in the work plan or *Section 5 – Decontamination of Field Equipment* in this SOP document before using it on each well.

7. Perform a standard site inspection. Refer to *Section 3 – Monitoring Station Inspections* in this SOP document for more information.
8. Talk to well owners about amount of use, age of well, and type of chlorination if applicable. Record this data on the field data sheet.

2.3 Initial Installation of Transducers

Transducers can be installed either on a stainless steel wire or direct-read cable. Direct-read cables allow for data collection without removing a transducer from the well, and in some models, compensation for atmospheric pressure. When a transducer is on a stainless steel wire, it must be completely removed from the well to download data. And, the test must be set to start in the future, and the transducer must be installed prior to the first measurement.

2.3.1 Equipment

- Stainless steel wire or direct read cable and well cap
- If using stainless steel wire:
    - Wire line counter
    - Carabineers (at least 2 per well)
    - Well caps and plugs with eye bolts attached
    - Stainless steel oval sleeve (at least 4 per well)
    - Wire rope thimble (at least 2 per well)
- Digital camera
- Tools (pipe wrench, pliers, channel locks, crowbar, crimper, wire cutters, etc.)
- Keys to access well sites
- Well owner contact information
- Water level measurement device (i.e. electric sounder) (see *Section 1 – Groundwater Level Monitoring* of this SOP document)
- Measuring tape for RP and well dimensions (in tenths of a foot)
- Project notebook, pen, pencil
- Maps
- Decontamination solution and equipment
- Field data sheets (transducer field data forms and site inspection for transducer installation forms)
- Shop towels

2.3.2 Preparation

1. Determine appropriate transducer type. Refer to water level histories and well inspection sheets for information on the appropriate transducer model and submergence rating.

2. Order transducers and direct read cables, if applicable. Allow several weeks for them to be delivered.

3. Order the following for the stainless steel cable hanging apparatus when direct read cables will not be used:

    a. Appropriate well caps and plugs for wells that will receive transducers (refer to field inspection sheets for size and tread type).

    b. Eye bolts, nuts, and lock nuts (one each per well). Eye bolts must be small enough to fit inside well caps or plugs and have an opening large enough for quick links.

    c. Length of stainless steel wire for total depth of each transducer, as determined in *Section 2.2 – Inspecting Wells for Transducer Suitability*.

    d. Type 304 Stainless Steel Oval Sleeve for 1/32" rope diameter, ¼" sleeve length. At least four per transducer are necessary.

    e. Type 304SS Light-Duty Wire Rope Thimble for 3/32", 7/64", and 1/8" wire rope diameter. At least two per transducer are necessary.

    f. Quick links with an opening that is large enough to fit item *e* and item *b* above into the opening. At least two per transducer are necessary.

4. When materials arrive, use wire counter to accurately measure wire lengths for each well. Assemble wire ends, and test them with weight and force. Roll wire onto individual cable reels for storage and transportation. This can also be done in the field.

5. Prepare well caps. Drill holes in the end of the well caps and plugs. Install the eye bolts with the nut on the inside of the cap or plug, and the lock nut on the outside. Tighten the lock nut to secure the eye bolt. Hammer the end of the eye bolt to the lock nut to prevent tampering.

6. Test transducers. Transducers need either to be tested in a test well or bucket, or they need to be checked within 2 weeks of installation to prevent loss of data due to malfunction. Test the transducer in the office using the following method:

    a. Inspect transducer, cap, and O-rings for damage or manufacturing defects.

    b. Attach appropriate transducer communication cable to the laptop computer and transducer. Follow directions to communicate and start a test as outlined below. Set the test to record every 30 seconds.

    c. Set up a test well or bucket with fresh water to submerge the transducer by at least a couple of feet.

    d. Insert transducer in the water after a sample test has been started.

    e. Write down the time the test started and the time the transducer was submerged. Use seconds in the notation.

    f. Record the time and amount of water added (in feet above the transducer's measuring point).

g. After a few minutes (i.e. several recorded measurements), add or remove water, and record the time and the new water level height.

h. Repeat Step *g* at least twice.

i. Remove transducer from the water, and record the time.

j. Dry off the transducer connection, and attach transducer to the laptop computer.

k. Stop the test (as described below), and process the data as necessary. Compare the data to your depth and time notes. Assess the transducer's accuracy and precision, and troubleshoot with the manufacturer as necessary to ensure reliable transducer data. Record your conclusions and the serial number of the transducer in the "in-house" transducer tracking sheet.

2.3.3 Procedures

1. Load all equipment needed for installation.
2. Perform a general site survey prior to site entry in accordance with the health and safety plan. And, if required by site-specific conditions, monitor the headspace of the well with PID or FID to determine the presence of volatile organic compounds, and record on the field data sheet.
3. Decontaminate all equipment as outlined in this SOP document before using it on each well. If possible and where applicable, start at the wells that are least contaminated and proceed to the wells that are most contaminated.
4. Identify and mark all RP locations.
5. Measure the water level below the reference point, and record the measurement and time on the field data sheet. Lock the water level indicator just above the water surface, and leave it in the well. Enter the manual water level into the transducer software, if applicable.
6. Completely fill out the field data sheets.
7. Record the manufacturer, model, serial number, the rated water level or pressure range, and installed depth of the transducer on the field data sheet.
8. If using stainless steel wire, skip to *Step 9*. If the transducer will be installed on a direct-read cable, attach it and carefully lower it into the well.
9. Connect the transducer and cable to the laptop computer. Open the appropriate software for the transducer model.
10. Set up the location information on the transducer.
11. Check and record battery power of the transducer. The battery power should be 100% when the transducer is installed.
12. If the water level indicator can safely be left in the well, raise it to just above the water level and skip to *Step 13*. If the water level indicator must be removed prior to transducer installation due to limited space inside the well, measure the water level below the reference point a second time, and record the measurement and time on the field data sheet. Remove the water level indicator from well. Enter the manual water level into the software in *Step 13* below, if applicable.

13. Start a new test on the transducer (see manufacturer instructions). Set the transducer for the next time interval designated by the project work plan. For example, set it to start on the next 15 minute time interval (i.e. :15, :30, :45, or :00) when recording measurements at increments of 15 minutes. Note: if the transducer is on stainless steel wire, the test should be started far enough in the future to allow for full installation of the transducer and settling of the water surface prior to the first measurement.
14. If the transducer is on a stainless steel wire, attach the transducer to the hanging wire, and carefully lower it into the well. If it is on a direct-read cable, disconnect it from the laptop and carefully secure it to the well head. Minimize disturbance to the water surface.
15. If the water level indicator was left in the well in *Step 12* above, measure the water level a third time, preferably a few seconds after the transducer records its first measurement. This will ensure that the water surface has not been disturbed when the transducer measures the water level. Record the measurement and time on the field data sheet.
16. Attach well casing cap and secure, as necessary. Clean up and secure the site.
17. Decontaminate all equipment as outlined in the work plan or *Section 5 – Decontamination of Field Equipment* of this SOP document.

2.4 Downloading Transducers

2.4.1 Equipment

There are a number of brands of transducers, all of which require different procedures for downloading data. The following equipment is needed for most types of transducers:

- Tools and supplies for adding or repairing line (extra quick links/carabineers, stainless steel oval sleeves, crimper, wire cutters, and wire rope thimbles)
- Tools for accessing wells (pipe wrench, pliers, channel locks, crowbar, etc.)
- Tools for replacing transducer batteries
- Batteries (check transducer for size)
- Keys to access well sites
- Well owner contact information
- Laptop computer
- Communication cables to connect transducers to laptop
- Water level measurement device (i.e. electric sounder) (see *Section 1 – Groundwater Level Monitoring* of this SOP document)
- Cord reel for retrieving transducer (at least 2)
- field data sheets
- Pen and/or pencil
- Decontamination solution and equipment
- Ruler or measuring tape

- Site maps
- Shop towels
- Digital camera

2.4.2 Preparation

1. Contact well owners to schedule access to site (if applicable).
2. Collect and review field inspection documents for each well scheduled for visiting.
3. Obtain necessary sampling and monitoring equipment. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Set the laptop computer to Pacific Standard Time, NOT Daylight Saving Time. Set it to within 1 second of the actual time. Use this site:

   www.time.gov

   This site is set to Daylight Saving Time; the laptop time may have to be converted to Pacific Standard Time when setting the laptop time (i.e. in summer months).

   Synchronize watch or other field time piece to the same time.

2.4.3 Procedures

Transducer data must be downloaded quarterly to prevent overload of onboard memory and battery power loss. Problems must also be checked for regularly so that minimal data is lost should a problem occur.

1. Perform a general site survey prior to site entry in accordance with the health and safety plan.
2. Start at the wells that are least contaminated and proceed to the wells that are most contaminated, if possible and where applicable.
3. Decontaminate all equipment as outlined in the project or site-specific work plan or *Section 5 – Decontamination of Field Equipment* of this SOP document between wells and at the end of the day.
4. Retrieve transducer or connect to direct read cable:
   a. Hanging Wire: If hanging on a stainless steel wire, securely attach the top of the hanging wire to the cord reel and carefully reel it up. Inspect hardware and wire, and replace if necessary. Dry the outside of the transducer at the connection point, and attach the transducer to the appropriate laptop communication cable.
   b. Direct Read Cable: If the transducer is on a direct read cable, dry the connection at the top of the cable (if necessary), and attach the communication cable with as little disturbance to the water surface as possible. The transducer data and settings can be accessed through the cable without removing the transducer from the well.
5. Check and record the battery power of the transducer.
6. Check and record the onboard memory level of the transducer.

7. Begin downloading the test (i.e. the onboard data collection program and recorded data). The test can be stopped prior to downloading to prevent the recording of data while the transducer is out of the well or the water surface is disturbed by manual measurements or movement of the transducer. Stop the transducer test only if the well is static, the onboard memory is low (allow for twice the amount of expected data points before the next scheduled download), or the battery power is 90% or less.
8. After the test had been downloaded to the laptop, delete the onboard test if it was stopped (see *Step 7* above).
9. Measure and record the depth to water on the field data sheet (reference point to water level, see *Section 1 – Groundwater Level Monitoring* of this SOP document). Compare the water level to the previous water level in the project specific fieldwork binder. Leave the water level measuring device in well.
10. Complete the information required on the field data sheet.
11. Change the batteries every time the current test has been stopped (see *Step 7* above) in transducers with removable batteries.
12. Update the internal clock of the transducer by syncing it to the laptop time, which is synchronized to official U.S. time (see *Section 2.3.2 – Preparation* above).
13. Check the manual water level against the transducer record after it has downloaded onto the laptop. If necessary, calculate the depth to water from transducer submergence (head) in feet. See *Section 2.6 – Calculations* below. If the data do not match, recheck the manual water level, look at the previous water level and notes, determine why there is a discrepancy, and make a note.
14. Recheck the manual water level to make sure it has not changed and record the measurement and time on the field data sheet. If the water level indicator can safely be left in the well, raise it to just above the water level and skip to *Step 15*. If the water level indicator must be removed prior to transducer installation due to limited space inside the well, remove it from well. Enter the manual water level into the software during *Step 15* below, if applicable.
15. Start a new test on the transducer (see manufacturer instructions). Set the transducer for the next time interval designated by the project work plan. For example, set it to start on the next 15 minute time interval (i.e. :15, :30, :45, or :00) when recording measurements at increments of 15 minutes. Note: if the transducer is on stainless steel wire, the test should be started far enough in the future to allow for full installation of the transducer and settling of the water surface prior to the first measurement.
16. If the water level indicator was left in the well in *Step 14* above, measure the water level a third time, preferably a few seconds after the transducer records its first measurement. This will ensure that the water surface has not been disturbed when the transducer measures the water level. Record the measurement and time on the field data sheet.
17. If the transducer is on a stainless steel wire, attach the transducer to the hanging wire, and carefully lower it into the well. If it is on a direct-read cable, disconnect it from the laptop and carefully secure it to the well head. Minimize disturbance to the water surface.
18. Clean up and secure the site. Replace the well casing cap and locks, as appropriate.

19. Note any physical changes—such as erosion or cracks in protective concrete pad or variation in the total depth of the well—on the field data sheets. Also, note changes to the well or pump installation and oil or dirt in the well.
20. Decontaminate all equipment as outlined in the project or site-specific work plan or in *Section 5 – Decontamination of Field Equipment* of this SOP document.

2.5 Reagents

Decontamination solutions are used in this procedure. Where the decontamination of equipment is required, refer to the project or site-specific work plan or *Section 5 – Decontamination of Field Equipment* of this SOP document.

2.6 Calculations

Check the manual water level against the transducer record after it has downloaded onto the laptop. If necessary, calculate the depth to water from transducer submergence (head) in feet.

$$DTW = (a^{i}+b^{i})-a^{current}$$

where:

DTW = depth to water

a^{i} = depth of water above transducer at time of water level sounding (from the transducer data)

b^{i} = depth to water from water level sounding

$a^{current}$ = depth of water above transducer at the time to be calculated

2.7 Quality Assurance/Quality Control

The following general quality assurance/quality control procedures apply:

- All data must be documented on standard field data sheets or within personal/site logbooks.
- All instrumentation must be operated in accordance with the operating instructions supplied by the manufacturer.
- The water level within each well should be tested at least twice in order to compare results and ensure reliability. If water levels change by more than 0.02 feet for inactive wells and 0.2 feet for active wells, measure the water level a third time. Record all measurements on the field data sheet.

2.8 Data Validation

Check the manual water levels against the transducer water levels. If necessary, calculate the drift of the transducer, and record it on the field data sheet.

2.9 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and site-specific health and safety procedures.

3 MONITORING STATION INSPECTIONS

3.1 Scope and Application

Inspection and documentation of all monitoring stations is critical to maintain current information on sites and to make adjustments to field monitoring plans.

3.2 Method Summary

The inspection process should be focused around the accurate documentation of all applicable aspects of the site as they relate to current and possible future monitoring applications. The process involves the documentation of as much information as possible for each station, using a variety of instruments.

3.3 Equipment

The following equipment is necessary for the completion of the inspection process:

- Tools
- Keys to access station
- GPS
- Digital camera
- Compass
- Measuring tape
- Permanent marker
- Marking paint
- Sketch form
- Pen or pencil

3.4 Preparation

1. Collect and review all field inspection sheets for each station scheduled for site inspection.
2. Determine if the inspection sheet and other information are complete or need revisions, and make note of those stations that will need to have a complete inspection performed. If a completed sketch exists, photographs are up-to-date, and are accurate, continue onto the sample/data collection process.
3. Prepare scheduling and coordinate with staff, clients, and regulatory agencies, if appropriate.

3.5 Procedures

If an inspection document has not been completed or needs to be updated, follow the procedures below to complete all information for each site.

1. Perform a general site survey prior to site entry in accordance with the health and safety plan.
2. Collect coordinates of the site or site components using GPS.
3. Create a sketch of the site on the sketch form.
    a. Include Well ID and Alias ID (where applicable). The Alias ID or Local Name may be written on the site.
    b. Include a general map, using major roads to show general site location and minor roads, trails, buildings, and private roads to show site location within the property. Note compass direction, and write well access comments (i.e. locked gate, escort required, etc.).
    c. Include a station sketch in map or profile view with compass direction. This will include all features of the site. For example, at a well site, this includes the well, any pump, discharge line(s), sampling ports, meters, on-site tanks, etc.
    d. Include a reference sketch in profile view with compass direction. This includes a sketch of the wellhead or lysimeter head, where data are gathered, etc. For wells, include any surface or below ground features that affect the site point (SP), reference point (RP), etc. Measure and record distances between the ground surface (GS), SP, and RP. Also, include pipe/casing diameters, where they can be determined.
4. Take the following photographs, as applicable to the site type:
    a. Site. This will document the entire site, including access to the site (roads, gates, etc.). Take several site photographs if necessary.
    b. Station. This will document all of the features of the site. For example, at a well site, include the pressure tank, the power and hours meters, the pump (if present), the SP, the RP(s), and the GS. If needed, take photographs from several directions. At well sites, take these photographs after the SP and RP have been marked.
    c. Reference Point. The RP photograph will be of the main RP where data are collected. Take photographs of any other possible RPs. Take one photograph for each RP. Take these photographs after the main RP has been marked.
    d. Flow Meter, Power Meter, Hours Meter. These photographs should be taken of each meter, perpendicular to the face. The text on the flow meter should be clearly legible so that it can be read later. This will help clarify units, decimal places, meter model, etc. Take more than one photograph of each meter if located inside of a box or away from the well.
    e. Water Quality Sampling Port. The water quality photograph should be of the port location on a well site and should show the port type.
    f. Pump Identification. The pump identification photograph (at well sites) should be taken of the tag on the pump (i.e. vertical turbine pumps) that identifies the serial number of the pump and other information about it, such as horse power.

3.6 Quality Assurance/Quality Control

Every time a site is visited, the site inspection information should be verified and updated as necessary.

3.7 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and site-specific health and safety procedures.

4 NUISANCE WATER

Nuisance water is defined here as moderate to heavy precipitation, standing water, or runoff. Nuisance water, if allowed to enter a well, can contaminate the well and aquifer(s) that the well is in communication with. When gaining access to a well, every effort must be taken to ensure that nuisance water does not enter the well.

When accessing a well with nuisance water present, the following procedures must be followed:

- Wells with access through an open top—such as piezometers or a production well without a pump—should be protected from heavy rain with the use of an instant canopy/shelter (e.g. an EZ-Up®) or an umbrella. If protection of this nature is not possible, contact the Project Manager or Field Manager to discuss the circumstances before accessing the well.
- When a damaged casing is encountered such that nuisance water can enter the casing, contact the Project Manager or Field Manager from the site to discuss the condition of the well and possible solutions. Take photographs of the part of the well of concern and the nearest surface water body or runoff path, if applicable, and follow up at the end of the day with an email to the Project Manager and Field Manager with the photographs attached.
- When runoff or standing water is in immediate danger of entering a well casing, the casing should not be opened. Contact the Project Manager or Field Manager from the site to discuss the circumstances. Take photographs of the well of concern and the nearest surface water body or runoff path, if applicable, and follow up at the end of the day with an email to the Project Manager and Field Manager with the photographs attached.

5 DECONTAMINATION OF FIELD EQUIPMENT

5.1 Scope and Application

Removing or neutralizing contaminants that have accumulated on sampling equipment ensures the protection of personnel from permeating substances, reduces or eliminates the transfer of contaminants to clean areas, prevents the mixing of incompatible substances, and minimizes the likelihood of sample cross-contamination.

5.2 Method Summary

Contaminants can be physically removed from equipment or deactivated by sterilization or disinfection. Gross contamination of equipment requires physical decontamination, including abrasive and non-abrasive methods. These include the use of brushes, air and wet blasting, and high pressure water cleaning, followed by a wash/rinse process using appropriate cleaning solutions. The use of a solvent rinse is required when organic contamination is present.

5.3 Interferences and Potential Problems

- The use of distilled/deionized water, commonly available from commercial vendors, may be used for decontamination of sampling equipment, provided that it has been verified by laboratory analysis to be analyte free.
- An untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal water treatment system for mixing decontamination solutions.
- Acids and solvents utilized in the decontamination sequence pose health and safety risks, such as inhalation or skin contact, and raise shipping concerns of permeation and/or degradation.
- The site work plan must address the disposal of the spent decontamination solutions.
- Several procedures can be established to minimize contact with waste and the potential for contamination. For example:
  - Utilize practices that minimize contact with hazardous substances.
  - Use remote sampling, handling, and container-opening techniques when appropriate.
  - Cover monitoring and sampling equipment with protective material to minimize contamination.
  - Use disposable outer garments and disposable sampling equipment when appropriate.

5.4 Equipment

- appropriate personal protective equipment
- non-phosphate detergent
- selected solvents

- long-handled plastic brushes
- drop cloths/plastic sheeting
- trash container
- paper towels
- galvanized tubs or buckets
- tap water
- distilled/deionized water
- metal/plastic containers for the storage and disposal of contaminated wash solutions
- pressurized sprayers for tap and deionized/distilled water
- sprayers for solvents
- trash bags
- aluminum foil
- safety glasses or a splash shield
- emergency eyewash bottle

5.5 Preparation

As part of the health and safety plan for each project or site, develop and set up a decontamination plan before any personnel or equipment enter areas of potential exposure. The equipment decontamination plan should include:

- the number, location, and layout of decontamination stations
- the decontamination equipment needed
- appropriate decontamination methods
- methods for the disposal of contaminated clothing, apparatus, and solutions (USEPA, 1994)

All personnel, samples, and equipment leaving a contaminated area of a site must be decontaminated. Various decontamination methods will physically remove contaminants and/or inactivate contaminants by disinfection or sterilization.

In many cases, gross contamination can be removed by physical means. The physical decontamination techniques appropriate for equipment decontamination can be grouped into two categories: abrasive methods and non-abrasive methods. Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. Non-abrasive cleaning methods work by forcing the contaminant off of a surface with pressure. In general, less of the equipment surface is removed using non-abrasive methods.

Disinfectants are a practical means of inactivating infectious agents. Standard sterilization methods involve heating the equipment; though sterilization is impractical for large or heat sensitive equipment. Rinsing removes contaminants through dilution, physical attraction, and solubilization.

5.5.1 Procedures

1. Where applicable, use a brush in each wash for the physical removal of contaminates.
2. Wash equipment with bleach and water solution.
3. Wash equipment with a non-phosphate detergent solution.
4. Rinse with tap water.
5. Rinse with distilled/deionized water.
6. Rinse with 10% nitric acid if the sample will be analyzed for trace metals.
7. Rinse with distilled/deionized water.
8. Use a solvent rinse (pesticide grade) if the sample will be analyzed for organics.
9. Air dry the equipment completely.
10. Rinse again with distilled/deionized water.
11. Towel dry sounder or steel tape equipment prior to winding it onto the spool.

The nitric acid rinse and subsequent distilled/deionized water rinses may be eliminated if metals are not of concern at a site. Similarly, the solvent rinse and subsequent air dry and distilled/deionized water rinse steps may be eliminated if organics are not of concern at the site. Selection of the solvent for use in the decontamination process is based on the contaminants present at the site. Typical solvents used for the removal of organic contaminants include acetone, hexane, or water. If a particular contaminant fraction is not present at the site, the ten-step decontamination procedure listed above may be modified for site specificity. The decontamination solvent used should not be among the contaminants of concern at the site (USEPA, 1994).

Table 1 lists solvent rinses that may be required for the elimination of particular chemicals. After each solvent rinse, the equipment should be air dried and rinsed with distilled/deionized water.

Sampling equipment that requires the use of plastic tubing must be disassembled, and the tubing should be replaced with clean tubing before the commencement of sampling and between sampling locations.

Table 1: Recommended Solvent Rinse for Soluble Contaminants

Solvent	Soluble Contaminants
Water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute Acids	Basic (caustic) compounds Amines Hydrazines
Dilute Bases – for example, detergent and soap	Metals Acidic compounds

	Phenol Thiols Some nitro and sulfonic compounds
Organic Solvents(1) – for example, alcohols, ethers, ketones, aromatics, straight-chain alkanes (e.g., hexane), and common petroleum products (e.g. fuel, oil, kerosene)	Nonpolar compounds (e.g. some organic compounds)

(1) - WARNING: Some organic solvents can permeate and/or degrade protective clothing.

(2) Source: (USEPA, 1994)

5.6 Reagents

The solvents used in this decontamination procedure are the reagents. The following solvents may be utilized for decontamination purposes:

- 10% nitric acid[1]
- acetone (pesticide grade)[2]
- hexane (pesticide grade)[2]
- methanol[2]

[1] Only if sample is to be analyzed for trace metals

[2] Only if sample is to be analyzed for organics (USEPA, 1994)

5.7 Quality Assurance/Quality Control

One type of quality assurance/quality control option specific to the field decontamination process is the rinsate blank. The rinsate blank provides information on the effectiveness of the decontamination process employed in the field.

A rinsate blank consists of a sample of analyte-free water (i.e. deionized) that is passed over and/or through a decontaminated field sampling device and placed in a clean sample container. The sample is then submitted to a laboratory for analysis of contaminates of interest.

Rinsate blanks should be run if stated in the work plan, if contamination is suspected, or when the decontamination procedure is modified. Rinsate blanks are not required if dedicated sampling equipment is used.

5.8 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and site-specific health and safety procedures.

Decontamination can pose hazards under certain circumstances even though performed to protect health and safety. Hazardous substances may be incompatible with decontamination methods. For example, the decontamination solution or solvent may react with contaminants to produce heat, explosion, or toxic products (USEPA, 1994). Decontamination methods may be incompatible with clothing or equipment: some solvents can permeate or degrade protective clothing. Also,

decontamination solutions and solvents may pose a direct health hazard to workers through inhalation, skin contact, or combustion.

The decontamination solutions and solvents must be determined to be compatible before use. Any method that permeates, degrades, or damages personal protective equipment must not be used. If decontamination methods pose a direct health hazard, measures must be taken to protect personnel or the methods should be modified to eliminate the hazard. (USEPA, 1994)

Decontamination solutions and solvents must be stored in appropriate containers and in temperature and humidity controlled environments, as specified on the product containers or MSDS sheets. Handling of these substances should be as specified on the product containers or MSDS sheets. Nitrile gloves, eye protection, and other personal protection equipment may be necessary.

5.9 References

U.S. Environmental Protection Agency. (1994). *Sampling Equipment Decontamination, SOP#: 2006.* Rev. #: 0.0. August 1994.